THE GTI HIGH-PERFORMANCE RADIANT TUBE SYSTEM: LOW-EMISSION NATURAL GAS BURNERS FOR ALLOY RADIANT U-TUBES IN METALS INDUSTRY APPLICATIONS

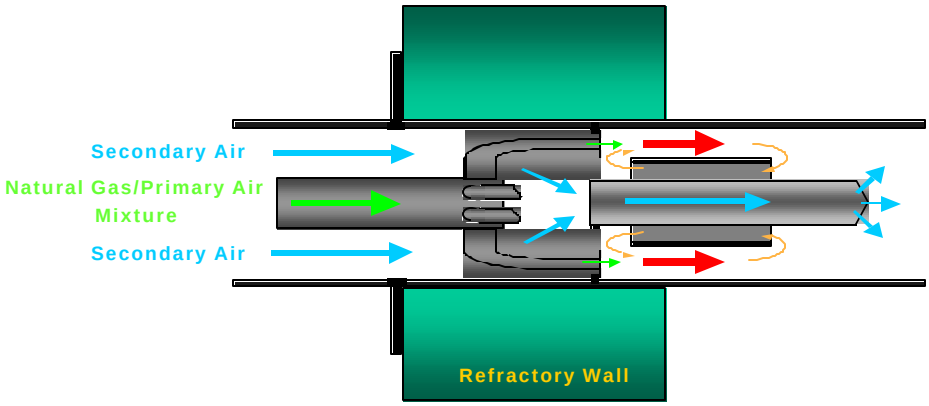
August 2004

EXECUTIVE SUMMARY (excerpts)

This project was intended to successfully demonstrate that GTI's Forced Internal Recirculation Burner (FIRB) can be applied to high temperature alloy radiant U-tubes for metals heat treating applications and reduce NO_x emissions by up to 60% from typical levels of approximately 200 ppmv.

The FIRB operates by utilizing three innovative techniques:

1. Combustion air/natural gas premixing
2. Combustion air staging
3. Forced internal recirculation of partial products of combustion from the primary zone in order to reduce peak flame temperatures



Forced Internal Recirculation Burner Concept for Radiant Tubes

GTI's FIRB technology has been commercially applied to industrial water tube boilers with success, but has yet to be applied to metal heat treating furnaces. These types of furnaces emit an estimated .003 - .004 tons of NO_x per day in California.

This demonstration project was conducted at ITW CIP Stampings located in Santa Fe Springs, California. Their #15 Heat Treat furnace was be utilized throughout this project. This is a three-zone austempering, mesh-belt furnace with a total of thirteen radiant U-tube burners.

Original Performance Goals:

- 60 % reduction in NO_x emissions

- 3 % reduction in CO emissions
- 3 % increase in energy efficiency
- 25% increase in radiant tube longevity as a result of the improved temperature uniformity
- Improved product quality because of the improved temperature uniformity thereby requiring less product rework and/or generating less waste

Original Project Goals:

- Develop and demonstrate a scaled-up FIR burner that can be applied to continuous metal processing furnaces that use radiant tubes (Task 1)
- Confirm the environmental, productivity, and energy savings, and determine the economics of this application by demonstrating the technology in a mesh belt furnace (Task 2)

Task 1 of the original ICAT grant:

1.1 Development of FIRB for 6" radiant U-tube

1.2 Fabrication of FIRB's for field Demonstration

Task 2 of the original ICAT grant:

2.1 Conduct baseline testing at ITW CIP Stampings

2.2 Install FIRB system & conduct field testing at ITW CIP Stampings

2.3 Evaluate & prepare technical report

Early in the conduct of Task 2.2, a design deficiency became apparent. Resources beyond those that the ICAT grant approved to expend were determined to be needed to continue a modified project to completion. Therefore, the work supported by the ICAT grant was concluded and the project is ongoing with other sources of support. Nevertheless, the limited data taken before the conclusion of the grant indicate a high potential for realization of the original goals once the design problem has been surmounted.

Results Prior to Burner Failure:

- > 68% reduction in NO_X emissions
  - Baseline: 199 ppmv Spot Checks: ~ 62 ppmv
- > 72% reduction in CO emissions
  - Baseline: 22 ppmv Spot Checks: ~ 6 ppmv
- > 5% fuel savings by increased preheat air temperature
  - Baseline: 550°F Spot Checks: ~ 800°F

These preliminary emission reductions and fuel savings compare baseline data from the conventional burners in averaged "as-is" condition (11/13/02 – 11/15/02)

to an average of spot checks of burner emissions and waste gas/preheated air temperatures during furnace operation with FIR burners (6/30/03 – 7/3/03).

Notwithstanding the shortened field trial, ITW CIP Stampings was impressed with the substantial reduction in emissions and, additionally, advised GTI that there was a significant reduction in furnace heat up time (from 180 minutes to 45 minutes) with the FIR burners installed. ITW CIP is eager to have GTI resolve the durability issues and proceed with the continued demonstration of this technology on their heat treat furnace.

GTI is currently working with the burner manufacturer, Eclipse Inc., to make the appropriate modifications to the FIRB design in efforts to successfully demonstrate the FIRB concept on this metals heat treating application. A lab-test prototype is scheduled to be performance tested during the fourth-quarter 2004 and a finalized FIRB will be demonstrated on ITW CIP Stampings' #15 Heat Treat Furnace in first-quarter 2005.